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Wading Birds as Biological Indicators: 1975 Colony Survey[1]

by

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Abstract

In 1975 we studied the suitability of wading birds (herons and their allies) as biological indicators in the coastal environment. Eight teams of investigators located and censused 198 colonies along the Atlantic coast from Maine to Florida. Fourteen species including over one-quarter million breeding birds were censused. The number of species in colonies ranged from 1 to 11. The number of one- and two-species colonies increased from Florida to Maine. Colony size decreased from Florida to Maine.

Wading bird colony sites are generally active each year and the number of colonies may have recently increased in some areas of the coast. Both species composition and total population of colonies fluctuate from year to year. The breeding population of wading birds was correlated with the area of coastal wetlands by State.

Five teams of investigators studied the reproductive biology of nine species in 13 colonies. Mean clutch size, the percentage of nests in which one or more eggs hatched, and the overall percentage of eggs that hatched differed among colonies for some species, but no latitudinal gradient was found in any of these characteristics for any species.

The use of wading birds to their full potential as biological indicators requires further exploration: survey and reproductive success methods need to be tested, the survey of colonies repeated, available historical information assembled, and habitat requirements measured.

In the next few years our nation's coastline will undergo additional rapid industrialization and development as new energy sources are found. These human activities will bring about increased waterway usage, habitat alteration or destruction, and pollution by chemicals, sediments, and wastes. Therefore, methods that allow early detection of detrimental changes in this zone must be developed.

Estuarine marshes have inherent aesthetic value as natural areas. In addition, they are among the most naturally fertile areas in the world (Odum 1961) providing nursery grounds for economically important fish and invertebrates (Ingle 1954).

One approach toward preservation of the highly productive estuary ecosystem involves the use of biological indicators. As defined here, a biological indicator is a population or assemblage of populations that reflects the ecological health of the environment.

The concept is not new. Primitive man must have realized it was unsafe to drink from a water supply that did not support certain forms of life (Thomas et al. 1973). Numerous examples of plants as natural biological indicators were compiled by Clements (1928), but perhaps the first experimentally chosen biological indicator was the canary (Burrell and Seibert 1914). The canary was an excellent indicator in mines because it was more sensitive than man to carbon monoxide.

More recently, examples of indicators have been discovered coincidentally after the fact. For instance, Borg et al. (1969) discovered that wild birds found dead or unhealthy in Sweden contained high levels of mercury. Restrictions were subsequently placed on uses of mercury that would pollute the environment.

Wading birds (herons and their allies) have been proposed as indicators of the state of our nation's estuarine ecosystems. They meet several useful requirements for this purpose. They are a terminal link in many aquatic food chains and may, as a result, reflect changes originating in several different ecosystem components. They are distributed over a wide geographic area and may indicate local changes in many areas. They nest in colonies that are easily

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monitored and can be sampled repeatedly. In addition, wading birds appear sensitive to certain kinds of environmental change. For example, Allen (1938) reported that urbanization was the major factor responsible for the loss of a number of colonies of black-crowned night heron *(Nycticorax nycticorax)* on Long Island, New York. Ohlendorf et al. (1974) found that pesticide residues in eggs of wading birds reflected pollution patterns along the Atlantic coast.

In 1975 we further explored the feasibility of using wading birds as biological indicators. The major premise of our study was that information on certain aspects of the population dynamics of wading birds could serve as indicators of environmental perturbations. Studies on other carnivores such as the brown pelican *(Pelecanus occidentalis)* (Anderson et al. 1975) and the peregrine falcon *(Falco peregrinus)* (Hickey 1969) also support this contention. In these species, declines observed in either reproductive success or adult numbers were traced to particular environmental problems.

Our first objective was to obtain baseline information on the location, composition, and abundance of wading birds nesting in colonies along the Atlantic coast. Our second objective was to identify and measure other biological characteristics likely to respond to environmental change. Those characteristics included reproductive success and habitat requirements for nesting and feeding.

The first objective was achieved in the first season and results are reported here. Most elements of the second objective require studies of more than 1 year. However, data obtained on reproductive success in selected colonies are included, and data on feeding and nesting site selection in the 1st year will be presented elsewhere.

Methods

Survey

Eight teams of investigators (Table 1) located and censused wading bird colonies along the Atlantic coast from Maine to Florida, including the Chesapeake, Delaware, and Florida Bays. River drainages and other inland sites also were searched as time and manpower allowed. The teams located colonies by contacting persons familiar with the areas, by conducting aerial searches, making ground surveys, and obtaining information from the Cornell North American Nest Record Card Program.

Investigators surveyed their study areas two or more times between April and September 1975. For each colony, census information was recorded on a standard form (Appendix I) and the location was indicated on a map. Some colonies were difficult to census because of topography, vegetation, or large numbers of birds and nests. As a result, some estimates are actual counts of nests or adults, whereas others are the product of a sample extrapolated to the entire colony.

This report presents the maximum breeding population estimate for each species surveyed in a colony. This estimate is either twice the number of nests or, if no nest estimate was taken, it is the number of adults. Only locations with four or more pairs of nesting wading birds were included in the analysis.

There were differences among investigators in their definition of a colony. Some investigators censused several adjacent groups of nesting birds as one colony whereas others censused such groups as distinct colonies. Because adjacent groups of nesting birds less than 1 km apart were considered a colony by some investigators, we tabulated all groups within 1 km of one another as a single colony.

Reproductive Success

Five teams of investigators (Table 2) studied the reproductive biology of wading birds along the Atlantic coast. They marked and observed nests in 13 colonies. In three instances (Table 2—colonies 72 and 92, and colony 93 of Appendix II) two adjacent groups of nesting birds, which were combined into one colony in the survey, were considered individual colonies for these analyses.

Nests were usually checked every 5 to 7 days (range 2 to 12) depending on weather, time limitations of cooperators, and concern of cooperators that frequent visits might be detrimental to nest or colony success. The number of "apparently viable," infertile, or broken eggs, the number of live or dead young in the nest, and the number of live or dead young near the nest were recorded on a standard form. In tall vegetation, observations were often made with the aid of a mirror attached to a pole.

Clutch size (the percentage of nests in which at least one egg hatched) and overall percentage of eggs that hatched were calculated for species in colonies where 10 or more nests were marked and revisited. The number of eggs hatched per nest was calculated as the maximum number of young (alive or dead) in or near the nest within 8 days after the first egg hatched. Where the number of marked nests of any species exceeded 25, a random sample of 25 was chosen.

It was not possible to obtain information on the success of nestlings to fledging because nestling wading birds tend to leave their nests soon after hatching, and most studies were not sufficiently intensive to obtain reliable data during this period.

Table 1. *Personnel and procedures of heron survey along the Atlantic coast.*

Region	Investigator	Procedures
Maine New Hampshire Massachusetts Rhode Island	William H. Drury Director Scientific Staff Massachusetts Audubon Society Lincoln, Massachusetts	letter survey telephone survey ground survey
Connecticut New York New Jersey	Phillip D. Creighton Department of Biological Science Towson State College Baltimore, Maryland	letter survey telephone survey aerial survey (airplane) ground survey
Delaware Maryland Virginia	Mitchell A. Byrd Department of Biology College of William and Mary Williamsburg, Virginia	aerial survey (airplane) ground survey
North Carolina	James F. Parnell Department of Biology University of North Carolina Wilmington, North Carolina Robert F. Soots, Jr. Department of Biology Campbell College Buies Creek, North Carolina	aerial survey (airplane, helicopter) ground survey
South Carolina	Lawrence J. Blus U.S. Fish and Wildlife Service Patuxent Wildlife Research Center Laurel, Maryland	aerial survey (airplane) ground survey
Georgia	Ron R. Odom Department of Natural Resources Georgia Game and Fish Division Social Circle, Georgia	aerial survey (airplane, helicopter) ground survey
Florida (Merritt Island north)	Stephen A. Nesbitt Game and Fresh Water Fish Commission Gainesville, Florida	aerial survey (airplane) ground survey
Florida (south of Merritt Island to and including Florida Bay)	James A. Kushlan U.S. National Park Service Everglades National Park Homestead, Florida	aerial survey (airplane) ground survey

Results

Survey

To be useful on a broad scale, a biological indicator should have a wide geographic distribution. One hundred ninety-eight wading bird colonies were recorded along the Atlantic coast from Maine to Florida (Fig. 1, Appendix II). Of the 14 species of wading birds that nest in Atlantic coast colonies, 10 breed along most of the coast (Table 3). All 14 species breed in Florida and the number of species of breeding birds decreases northward. The great blue heron, snowy egret, black-crowned night heron, and glossy ibis breed as far north as Maine (see Table 3 for scientific names). The breeding ranges of green heron, little blue heron, cattle egret, great egret, Louisiana heron, and yellow-crowned night heron extend into the New Jersey and Massachusetts area. The white ibis breeds from Florida to South Carolina. The remaining three species (reddish egret, wood stork, and roseate spoonbill) breed only in Florida.

Table 2. *Personnel and colony locations of heron reproductive studies along the Atlantic coast.*

Colony name[a]	Investigator
Spectacle Island, MA (173)	Jeremy J. Hatch Department of Biology University of Massachusetts, Harbor Campus Boston, Massachusetts
Clark's Island, MA (183)	Brian A. Harrington Manomet Bird Observatory Manomet, Massachusetts
Swash Bay, VA (96)	Mitchell A. Byrd, Thomas F. Wieboldt, and J. W. Bill Akers Department of Biology College of William and Mary Williamsburg, Virginia
Upper Middle Marsh, NC (93) Lower Middle Marsh, NC (93) Annex, NC (92) Phillips Island, NC (92) Emerald Island, NC (80)	John O. Fussell, III Box 520 Morehead City, North Carolina
Santee Gun Club, SC (70) Marsh Island, SC (62) White Banks, SC (63) Drum Island North, SC (72) Drum Island South, SC (72)	Gerald A. Grau and Fred M. Bagley Ohio Cooperative Wildlife Research Unit Ohio State University Columbus, Ohio

[a] Colony number of Appendix II is given in parentheses.

The three species most frequently encountered in the colonies were, in decreasing order, the great egret, snowy egret, and Louisiana heron (Table 4). Our feeding site studies in North Carolina demonstrated that these three species used the coastal estuaries for feeding more heavily than the other wading birds.

Over one-quarter million breeding birds were censused. The most abundant species, the white ibis, exceeded 79,000 individuals, and nearly 80% of these nested in two South Carolina colonies. The cattle egret, snowy egret, and Louisiana heron each exceeded 30,000 birds whereas the great egret, black-crowned night heron, and glossy ibis were estimated above 13,000. Each of the remaining species had less than 10,000 breeding adults.

The species composition of colonies showed two main latitudinal trends (Fig. 2). First, the proportion of colonies with only one or two species increased from south to north. The increase was significant (χ^2 = 27.0, df =3, $P<0.001$) from Florida (17.9%) to the Georgia-North Carolina region (32.0%) to the Virginia-New Jersey region (45.1%) to the New York-Maine region (75.8%).

The great blue heron, great egret, and the black-crowned night heron were the most frequent members of one- and two-species colonies. Of 44 one-species colonies, 33 contained great blue heron and 8 contained black-crowned night herons. Of the 38 two-species colonies, 27 included the great blue heron, 23 the great egret, and 9 the black-crowned night heron. Sixty of the 85 colonies containing great blue herons were one- or two-species colonies.

Second, when data from one- and two-species colonies were excluded, the median number of species per colony increased from Florida to the Virginia-New Jersey region. A median test indicated a significantly increasing trend (χ^2 = 9.1, df = 2, $P<0.025$) from Florida (median = 5.25) to the Georgia-North Carolina region (median = 5.85) to the Virginia-New Jersey region (median = 7.0). This trend, however, is overshadowed by the number of one- and two-species colonies in the North, which results in a general pattern of decreasing numbers of species from south to north. Recher (1971) also noted the large number of species of wading birds feeding in waters of Mid-Atlantic States. He suggested that an increase in the size, kind, and number of prey allowed wading birds to be more selective. It follows that a finer partitioning of food resources would allow greater species diversity and account for the observed

Fig. 1. Distribution of wading bird colonies along the Atlantic coast, 1975.

Table 3. *Breeding distribution of wading birds in coastal colonies of Atlantic states.*

Species	State[a]												
	FL	GA	SC	NC	VA	MD	DE	NJ	NY	CT	RI	MA	ME
Great blue heron *(Ardea herodias)*	X	X	X	X	X	X	X						X
Green heron *(Butorides virescens)*	X	X	X	X	X	X		X					
Little blue heron *(Florida caerulea)*	X	X	X	X	X	X	X	X	X			X	
Cattle egret *(Bubulcus ibis)*	X	X	X	X	X	X	X	X					
Reddish egret *(Dichromanassa rufescens)*	X												
Great egret *(Casmerodius albus)*	X	X	X	X	X	X	X	X	X		X	X	
Snowy egret *(Egretta thula)*	X	X	X	X	X	X	X	X	X	X	X	X	X
Louisiana heron *(Hydranassa tricolor)*	X	X	X	X	X	X	X	X	X				
Black-crowned night heron *(Nycticorax nycticorax)*	X	X	X	X	X	X	X	X	X	X	X	X	X
Yellow-crowned night heron *(Nyctanassa violacea)*	X		X	X	X	X		X					
Wood stork *(Mycteria americana)*	X												
Glossy ibis *(Plegadis falcinellus)*	X	X	X	X	X	X	X	X	X			X	X
White ibis *(Eudocimus albus)*	X	X	X	X									
Roseate spoonbill *(Ajaia ajaja)*	X												

[a] NH is not included since no colonies were located there.

trend. Another possibility is that diversity of the physical environment is greater in coastal regions of Mid-Atlantic States and so allows increased wading-bird diversity within colonies. The relationship between species diversity and diversity of the physical environment has been suggested by many authors (reviewed by Pianka 1966).

The number of breeding birds per colony, all species combined, decreased from south to north (Fig. 3), but the numbers overlapped sufficiently that differences between regions were not statistically significant (1-way ANOVA log colony size; $F = 2.6$; $df = 3,194$; $0.05 < P < 0.1$). Means (geometric) from south to north were: Florida, 514.4; Georgia-North Carolina, 319.3; Virginia-New Jersey, 247.4; and New York-Maine, 194.2.

Many colonies remain in the same site year after year. In our 1975 survey, we located 6 of 7 colonies that had been found along the North Carolina coast in 1958 by Quay and Funderburg (1958); 6 of 8 colonies found along the Georgia coast in 1970 by Johnson et al. (1974); and 9 of 10 colonies found in Chesapeake Bay in 1973 by Armistead (1974*a*). We also located 16 additional colonies along the coast of Georgia, 12 along the coast of North Carolina, and 6 in Chesapeake Bay. We do not know whether these are new colonies, old colonies in new locations, or colonies overlooked in the original surveys.

Historical information on species composition and population size suitable for comparison with the 1975 data were available for 18 colonies (Armistead 1974*a*, 1974*b*; Erichsen 1921; Grant 1971; Johnson et al. 1974;

Table 4. *Number of colonies and population sizes of wading bird species along the Atlantic coast, 1975.*

Species	No. colonies with species present	Estimated no. of breeding adults
Great blue heron	85	9,876
Green heron	33	526
Little blue heron	84	8,220
Cattle egret	64	32,476
Reddish egret	3	50
Great egret	119	17,578
Snowy egret	116	39,920
Louisiana heron	93	31,352
Black-crowned night heron	91	13,804
Yellow-crowned night heron	28	684
Wood stork	6	3,610
Glossy ibis	57	13,538
White ibis	24	79,216
Roseate spoonbill	7	914

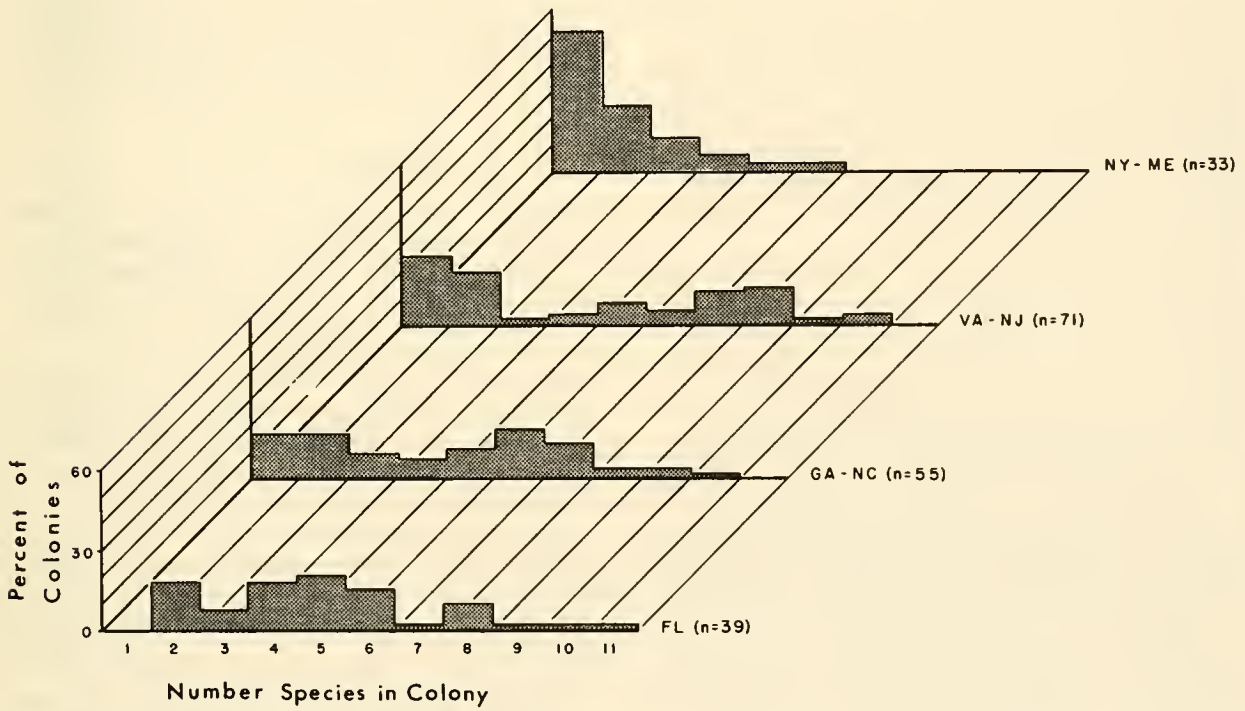

Fig. 2. The number of breeding wading bird species per colony in regions of the Atlantic coast, 1975. The number of colonies in each region is in parentheses.

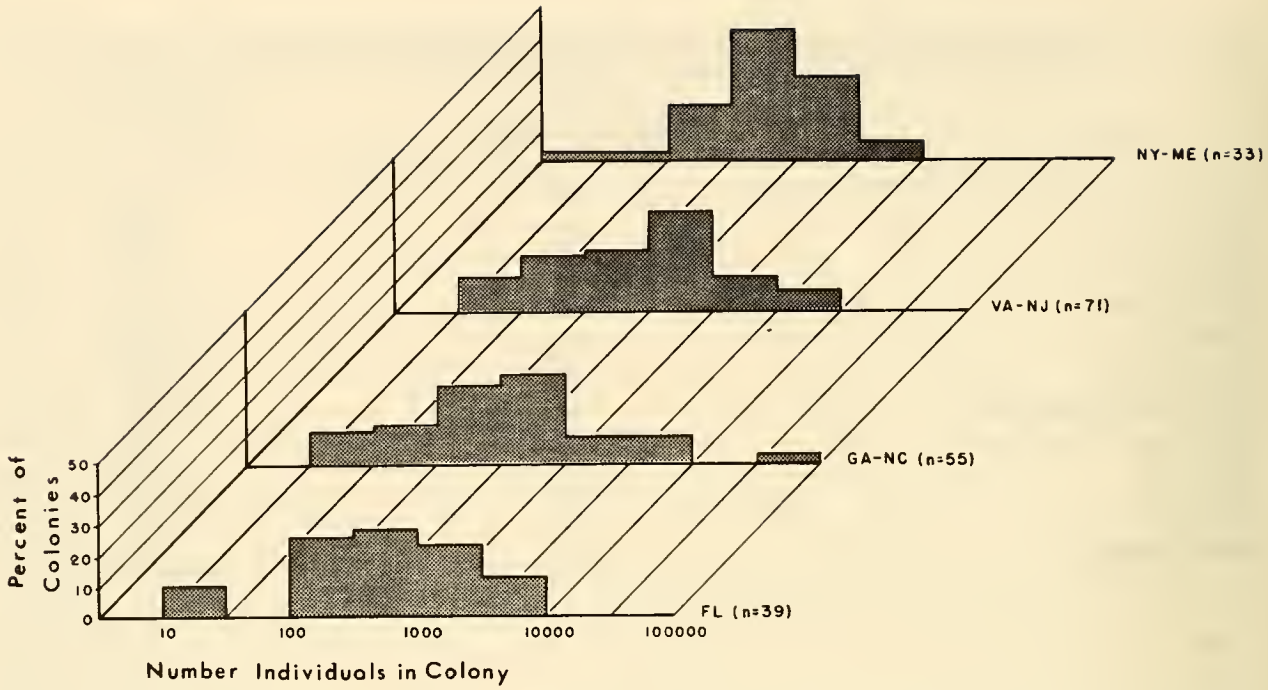

Fig. 3. The number of breeding wading birds per colony in regions of the Atlantic coast, 1975. The number of colonies in each region is in parentheses.

Kale 1965; Pearson 1922; Quay and Adams 1956; Quay and Funderburg 1958; Teal 1965). The number of species decreased in nine, increased in eight, and remained the same in one (Table 5). The total breeding population decreased in seven, increased in nine, and was similar to previous estimates in two. A detailed examination of reasons for these changes, which was not feasible during the 1975 season, should be revealing.

Atlantic coast wading bird abundance is grossly correlated to coastal wetland abundance. A significant rank correlation (Spearman rank correlation; $r_s = 0.92$, df = 12, $P<0.001$) was found between number of breeding wading birds per State (Table 6) and area of coastal wetlands by State (Spinner 1969). This correlation also proved true for the great egret ($r_s = 0.87$, df = 11, $P<0.002$), snowy egret ($r_s = 0.88$, df = 12, $P<0.001$), and Louisiana heron ($r_s = 0.75$, df = 8, $P<0.05$), which heavily utilize coastal wetlands for feeding. The correlation did not hold for the cattle egret, which generally feeds in pastures, nor for the great blue heron, little blue heron, or glossy ibis, which forage in inland freshwater sites as well as coastal wetlands. No significant correlation was found between coastal wetlands and the number of black-crowned night herons.

Thirty-five groups of nesting wading birds were pooled into 14 colonies by our definition. Of these 14 colonies, 10 (Appendix II; 59, 60, 61, 72, 91, 93, 124, 148, 150, 152) included two groups of nesting birds, one (151) included three groups, and three (92, 94, 149) included four groups. Our records for colony locations are incomplete; we know of at least three small colonies from which no data were obtained.

Reproductive Success

Reproductive patterns of nine species of wading birds were studied in 13 colonies: 2 in Massachusetts, 1 in Virginia, and 5 each in North and South Carolina. Data were obtained on clutch size, percentage of eggs that hatched, and percentage of nests in which at least one egg hatched.

Mean clutch size of five of eight species differed significantly among colonies (Table 7). Clutch size of snowy egrets even differed significantly between adjacent colonies in Massachusetts. There were no evident latitudinal gradients in clutch size.

The percentage of nests in which one or more eggs hatched differed among colonies for great egret, snowy egret, glossy ibis, and white ibis; latitudinal gradients were not apparent (Table 8). No differences were detected for little blue heron, cattle egret, Louisiana heron, or black-crowned night heron.

The overall percentage of eggs that hatched also differed among colonies for the cattle egret, great egret, snowy egret, Louisiana heron, and white ibis (Table 9). No significant differences were found for little blue heron, black-crowned night heron, and glossy ibis.

Table 5. *Historical changes in wading bird colonies of the Atlantic coast.*

Colony name[a]	Year[b]	Estimated number of breeding pairs											
		All species	Great blue heron	Green heron	Little blue heron	Cattle egret	Great egret	Snowy egret	Louisiana heron	Black-crowned night heron	Yellow-crowned night heron	Glossy ibis	White ibis
Satilla													
Rookery, GA (43)	1970[c]	2,089			15		100	88	75	3		8	1,800
	1975	3,563					1,000	250	800	5		8	1,500
Darien													
Rookery, GA (44)	1970[c]	1,413				19	13	25	17	14		75	1,250
	1975	55					25	25	5				
Blackbeard													
Island, GA (47)	1970[c]	108			5		38	50	15				
	1975	2,190			50	175	300	125	600	40			900
Sapelo													
Island, GA (59)	1958[d]	1,285					85	100	40	60			1,000
	1958[e]	2,825					100	100	50	75			2,500
	1975	72	1	2	30		10	3	5	21			
Ossabaw													
Island, GA (61)	1915[f]	275			85		10	10	165	5			
	1970[c]	231		9	4	33	51	98	15	18	3		
	1975	870			16	100	350	175	104	45			80
Santee													
River, SC (70)	1922[g]	1,125	150		240		460	100		175			
	1975	308	15		10	50	200	10	8	15			
Pea													
Island, NC (85)	1968[h]	315			*		*	*	*	*		15	
	1975	468			131	84	23	35	92	48		55	
Battery													
Island, NC (91)	1956[i]	372			30	2	100	45	160	20		15	
	1975	3,115		1	102	175	83	174	966	52		39	1,523
Alligator													
Bay, NC (94)	1968[j]	275		20	55	45	60	30	65				
	1969[j]	523		38	46	140	85	45	146			23	
	1970	369		10	49	81	68	40	114			7	
	1975	298		9	41	72	13	49	114				
Barren													
Island, MD (129)	1973[k]	1,013	55	5	75	449	77	150	1	31		165	
	1974[l]	850	35	12	140	360	33	120	10	10		130	
	1975	300	160				140						

(continued)

Table 5. *Historical changes in wading bird colonies of the Atlantic coast.* (Cont'd)

Colony name[a]	Year[b]	Estimated number of breeding pairs											
		All species	Great blue heron	Green heron	Little blue heron	Cattle egret	Great egret	Snowy egret	Louisiana heron	Black-crowned night heron	Yellow-crowned night heron	Glossy ibis	White ibis
Adam Island, MD (131)	1973[k]	19	8	5							6		
	1974[l]	15	6	5							4		
	1975	21	20								1		
Cherry Island, MD (132)	1973[k]	70	25				30					15	
	1975	400	30	7	10	40	40	63	40	100	10	60	
Deal Island, MD (133)	1973[k]	70	70										
	1975	81	80				1						
Wrap Island, MD (144)	1973[k]	219		5	33			15	48	45	3	70	
	1975	16		5			1		1		9		
Ewell, MD (147)	1973[k]	188		8	20				30	30	40	60	
	1975	57		2	5			5	5	25	10	5	
Holland Island, MD (149)	1973[k]	200	25	5	70		15	20	5	15	20	25	
	1974[l]	300	25	10	60	35	30	40	10	15	20	55	
	1975	1,182	91	8	73	50	113	377	61	310	39	60	
Kelly Island, MD (150)	1973[k]	285	5	5	70	40	10	50	30	25	15	35	
	1975	201	4	11	1		18		10	110	47		
Bloodsworth Island, MD (151)	1973[k]	238	180	20			30			5	3		
	1974[l]	173	120	20			25			5	3		
	1975	217	209	20			8						

[a] Colony number of Appendix II is given in parentheses.

[b] Estimates for 1975 are ours.

[c] Johnson et al. 1974. Number of nesting pairs estimated as one-half number of adults.

[d] Teal 1965.

[e] Kale 1965.

[f] Erichsen 1921.

[g] Pearson 1922.

[h] Quay and Funderburg 1958. Asterisk indicates individual estimate was not reported.

[i] Quay and Adams 1956.

[j] Grant 1971.

[k] Armistead 1974*a*.

[l] Armistead 1974*b*.

Table 6. *Number of colonies and population sizes of wading birds in 1975 and coastal wetland abundance in 1968 (Spinner 1969) in Atlantic states.*

State	No. colonies	Estimated no of breeding adults	Coastal wetlands (km^2)
Florida	39	52,494	1,106
Georgia	22	17,898	1,579
South Carolina	11	95,168	2,082
North Carolina	22	22,174	776
Virginia	30	22,446	798
Maryland	28	12,204	744
Delaware	2	4,734	443
New Jersey	11	14,148	873
New York	3	808	131
Connecticut	1	78	47
Rhode Island	3	816	8
Massachusetts	14	4,956	181
New Hampshire	0	0	15
Maine	12	3,840	117
Total	198	251,764	8,900

Discussion

The 1975 survey was the first attempt to cover all coastal wading bird colonies from Florida to Maine. Other surveys have included specific portions of the coast for various periods of time: New York coast (Bull 1964; Allen 1938); Maryland and Washington, D.C. (Stewart and Robbins 1958); portions of the Chesapeake Bay (Armistead 1974*a*, 1974*b*); North Carolina coast (Quay and Funderburg 1958); and the Georgia coast (Johnson et al. 1974).

Our study confirms that wading birds tend to reuse colony sites year after year. Of 25 historic colonies in Georgia, North Carolina, and Chesapeake Bay, 21 were active during this study. Comparisons of abandoned and reused colony sites from this survey and future surveys may reveal environmental changes.

The gross relationship between wetlands and certain wading bird species suggests that more precise data on habitat (now being obtained by National Wetland Inventory) and a better understanding of habitat use by different species (projected in present study) may pinpoint critical elements and enable detection of habitat changes before they become obvious. For example, the great egret, snowy egret, and Louisiana heron use estuaries for feeding to a greater extent than the other species. A decline in the populations of these three species in relation to others might, therefore, indicate declines of prey abundance in estuaries.

Although many investigators have used changes in bird numbers and reproductive success to indicate environmental problems (Ames and Mersereau 1964; Ratcliffe 1963; Borg et al. 1969; Hickey 1969; Blus et al. 1974), few studies have been made consistently enough in time, area, or method to take full advantage of the biological indicators.

In our study, data on reproductive success were gathered on 10 species and 13 locations. Reproductive information on eight species of colony nesting wading birds at nine locations in North America was found in the literature (Meanley 1955; Teal 1965; Wolford 1966; Dusi and Dusi 1968, 1970; Jenni 1969; Henny and Bethers 1971; Vermeer 1969; Pratt 1974; Weber 1975).

Evaluation of the full usefulness of reproductive characteristics as biological indicators requires a greater uniformity of procedure and consistency of recording data than was feasible in the 1975 survey. The difficulty of determining the number of young wading birds that fledge precludes use of this parameter on a broad scale. Some alternatives that were suggested by Ricklefs (1969) were employed in the 1975 studies.

Ricklefs (1969) suggested that when the ratio of the percentage of eggs that hatch to the percentage of nests in which at least one egg hatches is high, losses most likely are due to nest site competition, desertion, adult death, predation, or weather. When the ratio is low, losses most likely are due to hatching failure or

Table 7. *Clutch size of wading birds in selected colonies along the Atlantic coast. Listed are the mean ± standard error and, in parentheses, the number of nests sampled.*

Location	Species			
	Little blue heron	Cattle egret[a]	Great egret	Snowy egret[a]
Spectacle Island, MA	—	—	—	4.32 ± 0.14(25) A[b]
Clark's Island, MA	—	—	—	3.64 ± 0.11(25) B
Swash Bay, VA	—	—	—	3.20 ± 0.10(25) BC
Upper Middle Marsh, NC	—	—	2.76 ± 0.10(25)	2.92 ± 0.15(12) C
Lower Middle Marsh, NC	3.69 ± 0.19(15)	—	2.85 ± 0.08(20)	3.24 ± 0.19(25) BC
Annex, NC	3.92 ± 0.26(13)	2.48 ± 0.15(25)	2.64 ± 0.15(11)	—
Phillips Island, NC	—	—	2.72 ± 0.16(25)	—
Emerald Island, NC	3.92 ± 0.18(13)	2.96 ± 0.13(23)	2.86 ± 0.13(21)	—
Santee Gun Club, SC	—	—	2.68 ± 0.11(25)	—
Marsh Island, SC	—	—	—	3.60 ± 0.15(25) BC
White Banks, SC	—	—	—	3.32 ± 0.15(25) BC
Drum Island North, SC	—	—	—	3.00 ± 0.09(16) C
Drum Island South, SC	—	—	—	—

[a] One-way ANOVA or Student's "t" Test detected significant differences (α = 0.05) among colonies.

[b] Results of Student-Newman-Keuls multiple range test. A significant difference (α = 0.05) is indicated by those means not showing a common letter.

brood parasitism resulting from excessive partial losses of clutches. The glossy ibis on Clark's Island, Massachusetts, was the only population in which a low ratio occurred, suggesting hatching failure. Because hatching failure can result from high residue levels of pesticides in eggs (Heath et al. 1969; Longcore et al. 1971), this colony should be checked for such residues.

Use of wading birds to their full potential as biological indicators requires evaluations beyond those possible in a single year. First, survey methods should be tested for accuracy and efficiency. Alternate techniques must be tested, especially for large colonies and colonies located in difficult terrain or vegetation.

Second, disruptive effects of investigators on colonies should be quantified. Studies have suggested that decreased reproductive success could be correlated with increased frequency of visits (Burger, personal communication).

Third, additional historical information on colony location and composition should be assembled. There are several historical sources including Audubon warden reports, State and Federal game reports, and journal accounts.

Fourth, the coastal survey of colonies should be repeated to document normal fluctuations in colony location and species abundance. In addition, these comparisons may lead to the detection of environmental disturbance.

Fifth, habitat selection should be measured. Our preliminary studies demonstrated that species of wading birds select feeding and nesting sites that are different from other wading birds that are found in the same general area. Further data on habitat requirements are necessary before we can determine whether changes in the population dynamics of wading birds are indicative of certain perturbations in the environment surrounding colonies.

Sixth, methods of gathering data on reproductive success should be evaluated and made comparable within the limits of habitat differences. Variability of reproductive parameters should be measured to determine adequate sample sizes. Several biases that exist in most nest studies, including the wading bird studies described here, should be evaluated. These include yearly variation in nest success, criteria for determining nesting failure, influence of the stage at which nests are found, and frequency of visits to nests on reproductive success (reviewed by Ricklefs 1969).

Table 7—Cont.

Species				
Louisiana heron	Black-crowned night heron[a]	Yellow-crowned night heron	Glossy ibis[a]	White ibis[a]
—	3.68 ± 0.11(25) A	—	—	—
—	3.72 ± 0.15(25) A	—	3.38 ± 0.14(25)	—
3.12 ± 0.12(25)	—	—	—	—
—	—	—	—	—
3.12 ± 0.11(25)	—	—	—	—
—	3.12 ± 0.09(25) B	—	2.36 ± 0.15(22)	2.76 ± 0.14(25)
3.00 ± 0.21(10)	—	—	—	—
3.08 ± 0.21(13)	—	—	—	—
—	—	—	—	—
—	—	—	—	—
3.28 ± 0.18(25)	—	—	—	—
—	—	—	—	2.08 ± 0.12(25)
—	—	4.08 ± 0.11(25)	—	—

a, b See footnotes on page 12.

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Table 8. *Percentage of wading bird nests in which one or more eggs hatched. Number of nests is in parentheses.*

Location	Species								
	Little blue heron	Cattle egret	Great egret[a]	Snowy egret[a]	Louisiana heron	Black-crowned night heron	Yellow-crowned night heron	Glossy ibis[a]	White ibis[a]
Spectacle Island, MA	—	—	—	80(25)	—	84(25)	—	—	—
Clark's Island, MA	—	—	—	100(25)	—	92(25)	—	88(25)	—
Swash Bay, VA	—	—	—	96(25)	88(25)	—	—	—	—
Upper Middle Marsh, NC	—	—	64(25)	67(12)	—	—	—	—	—
Lower Middle Marsh, NC	100(15)	—	90(20)	100(25)	100(25)	—	—	—	—
Annex, NC	85(13)	76(25)	82(11)	—	—	92(25)	—	45(22)	72(25)
Phillips Island, NC	—	—	48(25)	—	100(10)	—	—	—	—
Emerald Island, NC	100(13)	91(23)	90(21)	—	100(13)	—	—	—	—
Santee Gun Club, SC	—	—	60(25)	—	—	—	—	—	—
Marsh Island, SC	—	—	—	100(25)	—	—	—	—	—
White Banks, SC	—	—	—	100(25)	96(25)	—	—	—	—
Drum Island North, SC	—	—	—	94(16)	—	—	—	—	36(25)
Drum Island South, SC	—	—	—	—	—	—	100(25)	—	—
Mean success	95(41)	83(48)			96(98)	89(75)			

[a] Significant differences detected among colonies for individual species by χ^2 difference among proportions test (significance level $\alpha = 0.05$).

Table 9. *Overall percentage of wading bird eggs that hatched. The number of eggs laid is in parentheses.*

Location	Species								
	Little blue heron	Cattle egret[a]	Great egret[a]	Snowy egret[a]	Louisiana heron[a]	Black-crowned night heron	Yellow-crowned night heron	Glossy ibis	White ibis[a]
Spectacle Island, MA	—	—	—	61(108)	—	74(92)	—	—	—
Clark's Island, MA	—	—	—	90(91)	—	96(83)	—	52(83)	—
Swash Bay, VA	—	—	—	83(80)	72(78)	—	—	—	—
Upper Middle Marsh, NC	—	—	58(69)	57(35)	—	—	—	—	—
Lower Middle Marsh, NC	84(55)	—	79(57)	86(83)	85(78)	—	—	—	—
Annex, NC	72(36)	52(84)	76(29)	—	—	81(77)	—	44(52)	72(69)
Phillips Island, NC	—	—	46(68)	—	90(30)	—	—	—	—
Emerald Island, NC	80(51)	75(68)	75(60)	—	93(40)	—	—	—	—
Santee Gun Club, SC	—	—	46(67)	—	—	—	—	—	—
Marsh Island, SC	—	—	—	91(90)	—	—	—	—	—
White Banks, SC	—	—	—	76(83)	83(82)	—	—	—	—
Drum Island North, SC	—	—	—	83(48)	—	—	—	—	25(52)
Drum Island South, SC	—	—	—	—	—	—	84(102)	—	—
Mean success	80(142)					83(252)		49(135)	

[a] Significant differences detected among colonies for individual species by χ^2 difference among proportions test (significance level $\alpha = 0.05$).

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Appendix I. Sample of form used in census of wading bird colonies.

HERONRY SURVEY FORM 197___

Colony No. _____ Survey No._____ Compiler_____ Survey Date_____ Arrival Time_____
State_____ County_____ Latitude _____ Longitude_____ Wind(MPH)_____
Time in Colony (min)_____ Tide (high,low;freshwater)_____ Size of Colony(acres)_____(1 acre=4840 yd^2)

		NUMBER OF ADULTS 1					NUMBER OF NESTS 2										
		ESTIMATE ±	CONFIDENCE E	G	F	P	ESTIMATE ±	CONFIDENCE E	G	F	P	NESTING STAGE % E	YI	YO	NEST LOCATION % GRND	SHRUB	TREE
	Great Blue Heron																
	Little Blue Heron																
	Cattle Egret																
	Snowy Egret																
	Great (Common) Egret																
	Louisiana Heron																
	Black-crowned Night Heron																
	Yellow-crowned Night Heron																
	Glossy Ibis																
	White Ibis																
assoc. spec.	Anhinga																
	Great Black-backed Gull																
	Laughing Gull																
	Herring Gull																
	Great Cormorant																
	Double-crested Cormorant																
	Brown Pelican																
other:																	

1) E=90-100%, G=75-90%, F=50-75%, P=<50% 2) E=% nests with eggs only, YI=% nests with at least 1 young (inc E) YO= % pairs with at least one young out of nest (includes YI)

Is the colony on an island? Yes___ No___
How did you reach the colony? airplane___ helicopter___ boat___ foot___ other_____
How did you census the colony? from the air___ from the ground___ from the water___ other_____
How old is the colony? (yrs)_____ How near is the colony to urban areas(miles)?_____
Was there disturbance or possible disturbance to the colony by others during your visit (boats,airplanes,roads,etc.)?___

Comments on colony habitat (topography,penetrability,height of vegetation,poison ivy,etc.)_____

Comments on reaching colony (local contacts, launching area, only at high tide,etc.)_____

Appendix II. Descriptions, locations, and census data of Atlantic coast wading bird colonies in 1975. Latitude and longitude are given to the nearest 30 s. The number of adults is the sum of the maximum breeding estimate of each species from multiple surveys on each colony. Species abbreviations are GBHE (great blue heron and, for colony 22, great white heron, *Ardea herodias occidentalis),* GRHE (green heron), LBHE (little blue heron), CAEG (cattle egret), REEG (reddish egret), GREG (great egret), SNEG (snowy egret), LOHE (Louisiana heron), BNHE (black-crowned night heron), YNHE (yellow-crowned night heron), WOIB (wood stork), GLIB (glossy ibis), WHIB (white ibis), and ROSP (roseate spoonbill).

Appendix II.

COLONY NO.	STATE	VEGETATION	LATITUDE	LONGITUDE	NO. SPECIES	NO. ADULTS
1	FL	MANGROVES	25 15 0	80 40 30	3	750
2	FL	MANGROVES & SHRUBS	25 16 30	80 52 30	4	666
3	FL	MANGROVES	25 18 0	80 54 30	2	4,300
4	FL	MANGROVES	25 12 30	80 46 30	3	334
5	FL	MANGROVES	25 6 30	80 56 30	6	228
6	FL	MANGROVES	27 38 0	80 22 0	8	4,960
7	FL	MANGROVES	27 41 30	80 24 0	5	1,318
8	FL	MANGROVES	27 47 0	80 27 0	5	962
9	FL	MANGROVES & SHRUBS	27 55 30	80 31 0	5	4,910
10	FL	MANGROVES	27 29 0	80 19 30	9	5,540
11	FL	MANGROVES	26 41 0	80 2 30	4	2,554
12	FL	MANGROVES & SHRUBS	27 11 30	80 11 0	8	570
13	FL	MANGROVES	25 6 30	80 54 30	10	2,860
14	FL	MANGROVES	25 2 0	81 1 0	5	688
15	FL	UNKNOWN	25 24 30	80 18 30	7	2,110
16	FL	MANGROVES	25 0 30	80 34 0	6	262
17	FL	MANGROVES	25 9 30	80 35 0	8	1,936
18	FL	TREES & SHRUBS	26 11 0	80 11 0	3	336
19	FL	UNKNOWN	26 4 30	80 12 30	5	130
20	FL	MANGROVES	25 56 30	80 8 30	8	1,318
21	FL	MANGROVES	25 8 0	80 30 0	2	16
22	FL	MANGROVES	24 55 0	80 46 30	6	190
23	FL	MANGROVES	25 3 30	80 28 30	6	242
24	FL	MANGROVES	24 55 30	80 40 0	2	146
25	FL	UNKNOWN	27 47 30	80 26 30	4	1, 40
26	FL	UNKNOWN	33 26 0	80 10 0	2	112
27	FL	UNKNOWN	33 26 0	80 10 0	2	28
28	FL	UNKNOWN	33 26 0	80 10 0	2	30
29	FL	MANGROVES	29 8 30	80 58 30	6	720
30	FL	MANGROVES & SHRUBS	28 21 0	80 40 30	5	1,750
31	FL	MANGROVES	28 17 30	80 39 30	4	464
32	FL	MANGROVES	28 22 30	80 37 0	2	10
33	FL	MANGROVES	28 49 0	80 46 30	5	242
34	FL	MANGROVES	28 44 0	80 46 30	6	602
35	FL	MANGROVES	28 42 30	80 48 0	4	1,144
36	FL	TREES, SHRUBS & MARSH	30 6 0	81 20 0	4	150
37	FL	WOODED MARSH	30 14 0	81 25 30	5	350
38	FL	MANGROVES	28 34 30	80 42 30	11	8,280
39	FL	MANGROVES	28 43 0	80 42 0	4	246
40	GA	TREES	30 51 30	81 31 0	1	30
41	GA	TREES, SHRUBS & MARSH	30 53 0	81 27 30	1	32
42	GA	TREES	30 53 30	81 25 0	6	854
43	GA	MARSH	30 58 0	81 29 30	6	7,126
44	GA	MARSH & SHRUBS	31 20 0	81 22 30	3	110
45	GA	TREES	31 24 30	81 21 30	2	116
46	GA	TREES & SHRUBS	31 31 30	81 14 0	1	32
47	GA	TREES	31 31 0	81 12 0	7	4,380
48	GA	TREES & SHRUBS	31 34 30	81 12 30	2	10
49	GA	TREES & SHRUBS	31 36 30	81 13 30	1	30
50	GA	TREES	31 37 30	81 13 0	1	12

Appendix II. Continued.

COLONY NO.	STATE	VEGETATION	LATITUDE	LONGITUDE	NO. SPECIES	NO. ADULTS
51	GA	TREES	31 37 30	81 17 0	6	628
52	GA	TREES & SHRUBS	31 38 0	81 10 30	5	420
53	GA	UNKNOWN	31 53 0	80 57 30	6	1,300
54	GA	TREES & SHRUBS	31 54 0	81 1 0	2	270
55	GA	TREES & SHRUBS	31 54 30	81 6 30	2	100
56	GA	TREES & SHRUBS	31 54 30	81 2 30	4	260
57	GA	TREES	31 56 0	81 1 30	3	124
58	GA	TREES & SHRUBS	31 58 30	80 55 0	2	44
59	GA	TREES	31 29 30	81 15 0	7	144
60	GA	SHRUBS	31 40 30	81 9 0	2	136
61	GA	TREES & SHRUBS	31 48 0	81 6 30	7	1,740
62	SC	MARSH	32 59 0	79 31 30	3	880
63	SC	MARSH & SHRUBS	33 1 0	79 30 0	5	928
64	SC	MARSH	32 32 30	80 10 0	3	2,504
65	SC	MARSH & SHRUBS	33 17 0	79 12 30	8	44,130
66	SC	TREES	32 14 0	80 44 30	5	108
67	SC	MARSH & SHRUBS	32 15 0	80 44 0	4	212
68	SC	UNKNOWN	32 11 30	80 43 30	3	540
69	SC	UNKNOWN	32 37 0	80 2 30	6	280
70	SC	WOODED MARSH	33 8 30	79 23 0	7	616
71	SC	TREES	34 6 30	79 16 0	5	538
72	SC	UNKNOWN	33 26 0	80 10 0	9	44,432
73	NC	TREES	35 53 0	76 59 30	1	70
74	NC	TREES	34 37 0	78 27 30	2	22
75	NC	TREES	33 55 30	78 12 0	1	10
76	NC	TREES	34 3 0	77 57 0	1	54
77	NC	TREES	34 6 30	77 57 30	1	58
78	NC	TREES	34 39 30	76 31 30	4	342
79	NC	SHRUBS	34 53 30	76 17 0	7	584
80	NC	SHRUBS	34 40 30	77 2 0	6	4,494
81	NC	SHRUBS	34 59 30	76 13 0	7	1,104
82	NC	TREES & SHRUBS	36 24 30	75 52 0	5	938
83	NC	SHRUBS	35 28 30	75 31 30	5	78
84	NC	SHRUBS	35 48 30	75 34 30	6	1,206
85	NC	SHRUBS	35 44 0	75 30 30	7	936
86	NC	TREES	36 29 0	77 57 30	2	320
87	NC	MARSH & SHRUBS	35 6 0	76 2 30	4	222
88	NC	SHRUBS	35 11 0	75 48 30	6	362
89	NC	SHRUBS	35 6 30	76 4 0	6	108
90	NC	WOODED MARSH	34 23 0	78 14 0	2	124
91	NC	SHRUBS	33 54 30	78 0 30	9	6,230
92	NC	TREES & SHRUBS	34 44 0	76 42 0	10	3,970
93	NC	SHRUBS	34 41 30	76 36 30	8	346
94	NC	TREES & SHRUBS	34 30 30	77 25 0	6	596
95	VA	TREES	37 26 30	75 41 0	8	4,554
96	VA	SHRUBS	37 32 0	75 41 0	6	686
97	VA	SHRUBS	37 41 30	75 35 0	7	1,284
98	VA	TREES & SHRUBS	37 35 0	75 37 30	6	1,624
99	VA	SHRUBS	37 46 30	75 32 0	6	262
100	VA	SHRUBS	37 55 0	75 26 0	7	496

Appendix II. Continued.

COLONY NO.	STATE	VEGETATION	LATITUDE	LONGITUDE	NO. SPECIES	NO. ADULTS
101	VA	SHRUBS	37 59 30	75 19 30	8	978
102	VA	TREES & SHRUBS	37 48 30	75 54 0	10	1,252
103	VA	TREES & SHRUBS	37 49 0	75 44 30	9	464
104	VA	SHRUBS	37 13 0	75 49 0	5	326
105	VA	TREES & SHRUBS	37 16 30	75 47 30	8	544
106	VA	TREES & SHRUBS	37 7 30	75 54 30	1	20
107	VA	TREES	37 50 30	76 27 30	1	80
108	VA	TREES	37 52 30	76 29 30	1	780
109	VA	TREES, SHRUBS & MARSH	37 3 30	77 1 30	3	60
110	VA	TREES	37 29 39	77 11 0	1	150
111	VA	TREES	37 20 0	76 18 0	1	700
112	VA	TREES	37 0 30	76 20 30	1	14
113	VA	TREES	37 11 30	76 31 0	1	110
114	VA	TREES	37 24 30	76 38 0	2	30
115	VA	TREES & SHRUBS	37 51 0	76 0 0	3	12
116	VA	TREES & SHRUBS	37 6 0	75 58 30	8	3,814
117	VA	TREES	37 29 0	76 29 0	1	92
118	VA	SHRUBS	37 16 0	76 31 0	1	102
119	VA	UNKNOWN	36 45 30	76 9 30	2	58
120	VA	TREES	36 40 0	75 56 0	1	30
121	VA	UNKNOWN	36 54 30	76 17 30	2	44
122	VA	TREES	36 53 30	76 7 30	2	148
123	VA	TREES	36 35 0	75 55 30	1	32
124	VA	SHRUBS	37 54 0	75 26 30	8	3,700
125	MD	SHRUBS	38 11 30	75 12 0	7	2,590
126	MD	MARSH & SHRUBS	38 9 30	75 15 0	4	106
127	MD	SHRUBS	38 5 30	75 18 30	5	194
128	MD	SHRUBS	38 5 0	75 12 30	2	34
129	MD	SHRUBS	38 19 30	76 15 30	2	600
130	MD	SHRUBS	38 18 30	76 13 30	7	600
131	MD	TREES & SHRUBS	38 9 0	76 5 0	2	42
132	MD	TREES & SHRUBS	38 1 30	76 2 0	10	800
133	MD	TREES	38 9 0	75 54 30	2	192
134	MD	TREES	38 25 30	77 13 0	1	416
135	MD	TREES	38 46 0	76 22 30	2	566
136	MD	TREES	39 1 30	76 13 0	1	450
137	MD	TREES	39 17 0	76 16 0	1	250
138	MD	TREES, SHRUBS & MARSH	38 14 0	76 47 30	4	412
139	MD	TREES & SHRUBS	38 14 30	76 8 30	1	22
140	MD	TREES	38 15 30	76 43 30	2	590
141	MD	TREES	39 27 0	75 57 30	1	180
142	MD	WOODED MARSH	38 9 30	76 2 30	2	54
143	MD	TREES	38 6 0	76 1 0	5	10
144	MD	SHRUBS	38 1 30	76 2 30	4	32
145	MD	TREES	37 57 30	76 2 30	2	84
146	MD	TREES & SHRUBS	37 59 0	76 2 30	9	490
147	MD	SHRUBS	37 59 30	76 1 30	7	114
148	MD	SHRUBS	38 15 30	75 7 0	5	122
149	MD	TREES & SHRUBS	38 7 30	76 5 0	10	2,364
150	MD	TREES & SHRUBS	37 58 30	76 1 0	7	402

Appendix II. Continued.

COLONY NO.	STATE	VEGETATION	LATITUDE	LONGITUDE	NO. SPECIES	NO. ADULTS
151	MD	TREES	38 11 30	76 2 30	2	434
152	MD	TREES	37 59 30	75 59 30	1	54
153	DE	SHRUBS	39 35 30	75 34 0	8	4,484
154	DE	UNKNOWN	39 30 0	75 36 30	1	250
155	NJ	TREES & SHRUBS	39 3 0	74 46 0	8	8, 54
156	NJ	TREES & SHRUBS	38 59 0	74 52 0	8	1,152
157	NJ	TREES & SHRUBS	38 59 0	74 51 0	3	376
158	NJ	TREES & SHRUBS	39 7 30	74 44 0	7	986
159	NJ	SHRUBS	39 17 0	74 35 0	8	1,264
160	NJ	WOODED MARSH	39 34 0	74 16 30	5	48
161	NJ	WOODED MARSH	39 33 30	74 16 30	5	370
162	NJ	MARSH & SHRUBS	39 35 0	74 15 0	2	22
163	NJ	TREES & SHRUBS	39 24 30	74 26 0	7	1,154
164	NJ	TREES & SHRUBS	39 25 0	74 26 0	7	550
165	NJ	WOODED MARSH	39 38 30	74 12 0	6	172
166	NY	TREES	40 36 0	73 31 0	4	134
167	NY	UNKNOWN	40 39 0	73 17 30	6	288
168	NY	TREES	40 37 0	73 26 30	4	386
169	CT	SHRUBS	41 4 0	73 22 30	2	78
170	RI	SHRUBS	41 36 0	71 21 0	2	506
171	RI	TREES & SHRUBS	41 37 0	71 13 30	2	162
172	RI	SHRUBS	41 12 30	71 34 0	1	148
173	MA	UNKNOWN	42 20 0	70 59 30	3	404
174	MA	UNKNOWN	42 17 0	70 57 0	2	150
175	MA	SHRUBS	41 31 0	71 3 30	1	66
176	MA	TREES	41 36 30	70 24 30	1	142
177	MA	SHRUBS	41 20 30	70 46 0	2	394
178	MA	SHRUBS	41 24 30	70 28 0	1	250
179	MA	SHRUBS	42 1 30	70 18 30	1	64
180	MA	SHRUBS	41 18 0	70 2 0	2	232
181	MA	WOODED MARSH	41 17 0	70 18 0	1	376
182	MA	TREES & SHRUBS	42 33 0	70 47 0	3	1,614
183	MA	TREES	42 0 30	70 51 0	5	1,106
184	MA	UNKNOWN	41 30 30	70 44 30	2	44
185	MA	SHRUBS	41 33 30	70 51 0	1	8
186	MA	SHRUBS	42 20 30	70 52 0	1	106
187	ME	TREES & SHRUBS	42 59 0	70 36 0	3	390
188	ME	UNKNOWN	43 30 0	70 19 30	3	918
189	ME	TREES	43 48 30	70 1 30	1	700
190	ME	TREES	43 46 30	69 34 30	1	232
191	ME	TREES	44 15 0	69 56 30	1	188
192	ME	TREES	44 7 30	68 47 0	1	74
193	ME	TREES	44 18 30	68 32 30	1	156
194	ME	UNKNOWN	44 23 0	68 54 0	1	30
195	ME	TREES & SHRUBS	43 54 30	69 25 0	2	600
196	ME	TREES	44 33 0	68 16 0	1	258
197	ME	TREES	44 27 0	67 52 30	1	198
198	ME	TREES	43 59 0	69 5 0	1	96

Appendix II. Continued.

COLONY	GBHE	GRHE	LBHE	CAEG	REEG	GREG	SNEG	LOHE	BNHE	YNHE	WOIB	GLIB	WHIB	ROSP
1	0	0	0	0	0	200	300	0	0	0	250	0	0	0
2	0	0	0	0	0	180	32	234	0	0	220	0	0	0
3	0	0	0	0	0	2100	0	0	0	0	2200	0	0	0
4	0	0	0	0	0	130	192	12	0	0	0	0	0	0
5	6	0	0	0	2	60	44	0	2	0	0	0	0	114
6	0	0	138	1596	0	152	1788	442	10	2	0	0	832	0
7	2	0	18	782	0	0	0	170	0	0	0	0	346	0
8	0	0	12	698	0	0	4	186	0	0	0	0	62	0
9	0	0	98	3378	0	0	480	342	0	0	0	0	622	0
10	28	0	78	2888	0	118	1140	788	16	2	0	0	482	0
11	0	0	0	1762	0	114	452	226	0	0	0	0	0	0
12	8	0	8	324	0	82	38	52	4	0	0	0	54	0
13	38	0	64	24	16	700	84	202	2	0	0	0	1682	48
14	22	0	2	0	0	106	40	518	0	0	0	0	0	0
15	12	0	38	1758	0	36	4	50	0	0	0	0	212	0
16	18	0	0	0	0	60	28	86	0	0	0	0	20	50
17	4	0	2	0	32	6	12	1220	0	0	0	0	30	630
18	0	0	2	294	0	40	0	0	0	0	0	0	0	0
19	0	0	44	10	0	50	0	8	0	18	0	0	0	0
20	0	0	26	1162	0	6	2	26	2	12	0	0	82	0
21	0	0	0	0	0	8	8	0	0	0	0	0	0	0
22	22	0	0	0	0	40	68	36	0	0	0	0	8	16
23	0	0	6	0	0	2	76	98	0	0	0	0	30	30
24	26	0	0	0	0	120	0	0	0	0	0	0	0	0
25	50	0	0	0	0	400	0	0	40	0	550	0	0	0
26	16	0	0	0	0	96	0	0	0	0	0	0	0	0
27	22	0	0	0	0	6	0	0	0	0	0	0	0	0
28	4	0	0	0	0	0	0	0	0	0	0	0	0	26
29	0	0	50	400	0	70	50	100	50	0	0	0	0	0
30	0	0	50	1600	0	20	30	50	0	0	0	0	0	0
31	0	0	0	400	0	20	20	24	0	0	0	0	0	0
32	8	0	0	0	0	0	0	0	0	2	0	0	0	0
33	24	0	0	150	0	44	0	12	12	0	0	0	0	0
34	0	0	50	250	0	0	60	200	0	0	0	2	40	0
35	0	0	24	800	0	0	20	300	0	0	0	0	0	0
36	0	0	30	0	0	80	30	10	0	0	0	0	0	0
37	0	0	20	100	0	100	0	40	0	0	90	0	0	0
38	30	10	300	1250	0	400	1000	1300	40	0	300	250	3400	0
39	0	0	0	100	0	6	40	100	0	0	0	0	0	0
40	30	0	0	0	0	0	0	0	0	0	0	0	0	0
41	32	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	30	80	0	90	30	0	24	0	0	0	600	0
43	0	0	0	0	0	2000	500	1600	10	0	0	16	3000	0
44	0	0	0	0	0	50	50	10	0	0	0	0	0	0
45	36	0	0	0	0	80	0	0	0	0	0	0	0	0
46	32	0	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	100	350	0	600	250	1200	80	0	0	0	1800	0
48	2	0	0	0	0	8	0	0	0	0	0	0	0	0
49	30	0	0	0	0	0	0	0	0	0	0	0	0	0
50	12	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix II. Continued.

COLONY	GBHE	GRHE	LBHE	CAEG	REEG	GREG	SNEG	LOHE	BNHE	YNHE	WOIB	GLIB	WHIB	ROSP
51	0	0	10	130	0	400	60	8	20	0	0	0	0	0
52	0	0	50	100	0	120	80	70	0	0	0	0	0	0
53	0	0	60	100	0	300	300	480	60	0	0	0	0	0
54	70	0	0	0	0	200	0	0	0	0	0	0	0	0
55	50	0	0	0	0	50	0	0	0	0	0	0	0	0
56	0	0	6	0	0	150	100	0	4	0	0	0	0	0
57	0	0	0	0	0	80	14	0	30	0	0	0	0	0
58	24	0	0	0	0	20	0	0	0	0	0	0	0	0
59	2	4	60	0	0	20	6	10	42	0	0	0	0	0
60	0	0	0	0	0	112	24	0	0	0	0	0	0	0
61	0	0	32	200	0	700	350	208	30	0	0	0	160	0
62	0	0	0	0	0	60	430	390	0	0	0	0	0	0
63	0	0	6	4	0	0	488	410	0	0	0	20	0	0
64	0	0	0	0	0	0	1254	1236	0	0	0	14	0	0
65	0	0	400	500	0	1000	900	2000	80	0	0	250	39000	0
66	8	0	0	0	0	68	14	10	8	0	0	0	0	0
67	0	0	32	2	0	0	122	56	0	0	0	0	0	0
68	0	0	328	0	0	0	132	80	0	0	0	0	0	0
69	0	10	6	120	0	26	70	48	0	0	0	0	0	0
70	30	0	20	100	0	400	20	16	30	0	0	0	0	0
71	0	0	54	322	0	44	116	0	0	0	0	0	2	0
72	0	0	2046	1000	0	600	11000	4618	368	144	0	1104	23552	0
73	70	0	0	0	0	0	0	0	0	0	0	0	0	0
74	2	0	0	0	0	20	0	0	0	0	0	0	0	0
75	10	0	0	0	0	0	0	0	0	0	0	0	0	0
76	54	0	0	0	0	0	0	0	0	0	0	0	0	0
77	58	0	0	0	0	0	0	0	0	0	0	0	0	0
78	0	0	60	0	0	32	66	184	0	0	0	0	0	0
79	0	0	32	228	0	24	36	172	14	0	0	78	0	0
80	0	30	600	1378	0	334	600	1552	0	0	0	0	0	0
81	0	0	148	42	0	36	148	452	16	0	0	262	0	0
82	0	0	50	600	0	136	76	76	0	0	0	0	0	0
83	0	0	0	0	0	14	22	26	8	0	0	8	0	0
84	0	0	54	0	0	72	394	408	70	0	0	208	0	0
85	0	0	262	168	0	46	70	184	96	0	0	110	0	0
86	112	0	0	0	0	208	0	0	0	0	0	0	0	0
87	0	0	4	0	0	0	78	128	0	0	0	12	0	0
88	0	0	50	0	0	24	50	124	24	0	0	90	0	0
89	0	0	26	0	0	8	8	52	10	0	0	4	0	0
90	4	0	0	0	0	120	0	0	0	0	0	0	0	0
91	0	2	204	350	0	166	348	1932	104	0	0	78	3046	0
92	0	2	494	1274	0	198	402	1130	164	2	0	150	154	0
93	0	4	30	2	0	112	62	110	18	0	0	8	0	0
94	0	18	82	144	0	26	98	228	0	0	0	0	0	0
95	0	0	120	60	0	150	800	700	300	24	0	2400	0	0
96	0	4	2	0	0	2	300	360	0	0	0	18	0	0
97	0	0	60	60	0	60	500	400	4	0	0	200	0	0
98	0	6	70	0	0	0	750	650	8	0	0	140	0	0
99	0	0	0	8	0	6	80	100	28	0	0	40	0	0
100	0	0	16	30	0	50	40	40	160	0	0	160	0	0

Appendix II. Continued.

COLONY	GBHE	GRHE	LBHE	CAEG	REEG	GREG	SNEG	LOHE	BNHE	YNHE	WOIB	GLIB	WHIB	ROSP
101	0	2	42	100	0	80	370	140	40	0	0	204	0	0
102	280	8	44	94	0	26	360	140	250	16	0	34	0	0
103	2	18	4	80	0	20	270	30	26	0	0	14	0	0
104	0	16	0	0	0	22	120	150	18	0	0	0	0	0
105	0	20	34	40	0	20	100	208	82	0	0	40	0	0
106	0	0	0	0	0	0	0	0	0	20	0	0	0	0
107	80	0	0	0	0	0	0	0	0	0	0	0	0	0
108	780	0	0	0	0	0	0	0	0	0	0	0	0	0
109	52	0	0	0	0	6	0	0	0	2	0	0	0	0
110	150	0	0	0	0	0	0	0	0	0	0	0	0	0
111	700	0	0	0	0	0	0	0	0	0	0	0	0	0
112	0	0	0	0	0	0	0	0	0	14	0	0	0	0
113	110	0	0	0	0	0	0	0	0	0	0	0	0	0
114	18	0	0	0	0	0	0	0	0	12	0	0	0	0
115	0	0	2	0	0	2	8	0	0	0	0	0	0	0
116	0	0	160	800	0	230	610	84	1810	20	0	100	0	0
117	92	0	0	0	0	0	0	0	0	0	0	0	0	0
118	0	102	0	0	0	0	0	0	0	0	0	0	0	0
119	50	0	0	0	0	8	0	0	0	0	0	0	0	0
120	30	0	0	0	0	0	0	0	0	0	0	0	0	0
121	24	0	0	0	0	0	0	0	0	20	0	0	0	0
122	8	0	0	0	0	140	0	0	0	0	0	0	0	0
123	32	0	0	0	0	0	0	0	0	0	0	0	0	0
124	0	2	170	250	0	60	1280	1020	90	0	0	828	0	0
125	0	0	240	600	0	100	550	400	100	0	0	600	0	0
126	0	0	0	2	0	0	50	50	0	0	0	4	0	0
127	0	4	0	0	0	0	144	2	28	0	0	16	0	0
128	0	0	0	0	0	0	26	0	8	0	0	0	0	0
129	320	0	0	0	0	280	0	0	0	0	0	0	0	0
130	0	10	50	360	0	0	120	10	30	0	0	20	0	0
131	40	0	0	0	0	0	0	0	0	2	0	0	0	0
132	60	14	20	80	0	80	126	80	200	20	0	120	0	0
133	190	0	0	0	0	2	0	0	0	0	0	0	0	0
134	416	0	0	0	0	0	0	0	0	0	0	0	0	0
135	550	0	0	0	0	16	0	0	0	0	0	0	0	0
136	450	0	0	0	0	0	0	0	0	0	0	0	0	0
137	250	0	0	0	0	0	0	0	0	0	0	0	0	0
138	2	0	0	0	0	198	204	0	8	0	0	0	0	0
139	22	0	0	0	0	0	0	0	0	0	0	0	0	0
140	520	0	0	0	0	70	0	0	0	0	0	0	0	0
141	180	0	0	0	0	0	0	0	0	0	0	0	0	0
142	34	0	0	0	0	20	0	0	0	0	0	0	0	0
143	2	2	0	0	0	2	2	0	0	2	0	0	0	0
144	0	10	0	0	0	2	0	2	0	16	0	0	0	0
145	44	0	0	0	0	40	0	0	0	0	0	0	0	0
146	20	10	70	0	0	10	130	70	50	10	0	120	0	0
147	0	4	10	0	0	0	10	10	50	20	0	10	0	0
148	0	60	2	0	0	6	46	8	0	0	0	0	0	0
149	182	16	146	100	0	226	754	122	630	78	0	120	0	0
150	8	22	2	0	0	36	0	20	220	94	0	0	0	0

Appendix II. Continued.

COLONY	GBHE	GRHE	LBHE	CAEG	REEG	GREG	SNEG	LOHE	BNHE	YNHE	WOIB	GLIB	WHIB	ROSP
151	418	0	0	0	0	16	0	0	0	0	0	0	0	0
152	54	0	0	0	0	0	0	0	0	0	0	0	0	0
153	14	0	70	2850	0	120	250	100	240	0	0	840	0	0
154	250	0	0	0	0	0	0	0	0	0	0	0	0	0
155	0	0	44	6	0	720	2440	14	2180	10	0	2640	0	0
156	0	0	16	4	0	10	250	6	60	6	0	800	0	0
157	0	0	10	8	0	84	170	20	34	10	0	40	0	0
158	0	4	76	0	0	50	472	0	234	100	0	50	0	0
159	0	0	24	20	0	60	950	16	70	4	0	120	0	0
160	0	20	4	0	0	0	6	0	12	0	0	6	0	0
161	0	46	70	0	0	0	202	0	6	0	0	46	0	0
162	0	12	0	0	0	0	0	0	10	0	0	0	0	0
163	0	0	140	4	0	10	550	250	90	0	0	110	0	0
164	0	30	94	0	0	16	240	106	34	0	0	30	0	0
165	0	4	8	0	0	4	92	0	28	0	0	36	0	0
166	0	0	0	0	0	46	32	0	10	0	0	46	0	0
167	0	0	4	0	0	40	130	4	80	0	0	30	0	0
168	0	0	0	0	0	84	168	0	10	0	0	124	0	0
169	0	0	0	0	0	0	24	0	54	0	0	0	0	0
170	0	0	0	0	0	0	6	0	500	0	0	0	0	0
171	0	0	0	0	0	36	0	0	126	0	0	0	0	0
172	0	0	0	0	0	0	0	0	148	0	0	0	0	0
173	0	0	0	0	0	0	108	0	282	0	0	14	0	0
174	0	0	0	0	0	0	6	0	144	0	0	0	0	0
175	0	0	0	0	0	0	0	0	66	0	0	0	0	0
176	0	0	0	0	0	0	0	0	142	0	0	0	0	0
177	0	0	0	0	0	0	8	0	386	0	0	0	0	0
178	0	0	0	0	0	0	0	0	250	0	0	0	0	0
179	0	0	0	0	0	0	0	0	64	0	0	0	0	0
180	0	0	0	0	0	0	4	0	228	0	0	0	0	0
181	0	0	0	0	0	0	0	0	376	0	0	0	0	0
182	0	0	0	0	0	0	506	0	1016	0	0	92	0	0
183	0	0	10	0	0	6	300	0	700	0	0	90	0	0
184	0	0	0	0	0	0	24	0	20	0	0	0	0	0
185	0	0	0	0	0	0	0	0	8	0	0	0	0	0
186	0	0	0	0	0	0	0	0	106	0	0	0	0	0
187	0	0	0	0	0	0	200	0	112	0	0	78	0	0
188	0	0	0	0	0	0	222	0	202	0	0	494	0	0
189	700	0	0	0	0	0	0	0	0	0	0	0	0	0
190	232	0	0	0	0	0	0	0	0	0	0	0	0	0
191	188	0	0	0	0	0	0	0	0	0	0	0	0	0
192	74	0	0	0	0	0	0	0	0	0	0	0	0	0
193	156	0	0	0	0	0	0	0	0	0	0	0	0	0
194	30	0	0	0	0	0	0	0	0	0	0	0	0	0
195	502	0	0	0	0	0	0	0	98	0	0	0	0	0
196	258	0	0	0	0	0	0	0	0	0	0	0	0	0
197	198	0	0	0	0	0	0	0	0	0	0	0	0	0
198	96	0	0	0	0	0	0	0	0	0	0	0	0	0

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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